REBUILDING AGRICULTURAL MARKETS PROGRAM RAMP IRRIGATION IMPACT ASSESSMENT REPORT

JUNE 2006

REBUILDING AGRICULTURAL MARKETS PROGRAM (RAMP)

RAMP Impact Assessment # 1
Irrigation Rehabilitation

Submitted by:

Chemonics International, Inc.
Contract No. 306-C-03-00-00502-00

Submitted to:
Afghanistan Mission
U.S. Agency for International Development
Kabul, Afghanistan

June, 2006

RAMP: Irrigation Impact Assessment

SUMMARY …… **1**

I. INTRODUCTION …… **3**

1.1 Afghanistan Irrigation Systems …… 5
1.2 Scope and Objectives …… 7

II. METHODOLOGY …… **8**

2.1 Data Collection …… 8
2.2 Conceptual Framework …… 9
2.3 Quantification of Impacts …… 11
2.4 Assumptions and Coefficients …… 12

III. RESULTS …… **15**

3.1 Land Reclamation …… 15
3.2 Agricultural Production …… 16
3.3 Cropping Pattern …… 17
3.4 Crop Diversification and Concentration …… 17
3.5 Cropping intensity …… 17
3.6 Area Shift …… 19
3.7 Food Security …… 19
3.8 Crop Intensification …… 20
3.9 Backward and Forward Linkages …… 20
3.10 Estimated Value …… 21

IV. CONCLUSION …… **21**

ANNEXES …… **24**

Summary

Irrigation has historically played a very important role in Afghan agriculture. The technology of gravity-flow irrigation *(kareze)* in particular has been used from time immemorial. Many small-scale community-based irrigation systems were also developed by successive governments. Over the past 20 years, however, the irrigation infrastructure has sustained destruction and neglect. At the same time, the Afghan population has risen from 15M in the 1970s to an estimated 25M in 2006, leading to a corresponding decline in per capita food availability. From being near self-sufficient in food production in the late 1970s, Afghanistan has now become a food deficit country. Large quantities of imports were made annually to supplement food aid from UN organizations. Agriculture has to grow at least on a par with population in order to address the food demands of the growing population. Rehabilitation of irrigation infrastructure is probably the single most important intervention required to increase agriculture production.

During the course of 2004 to 2006, RAMP has rehabilitated 33 irrigation systems in eight provinces. They constitute drains, flood control, dams, canal cleaning and intake construction. This impact assessment measures the economic benefits of the irrigation systems by comparing the without rehabilitation situation with rehabilitation. Data on land uses and season-wise crop area is compiled from surveys implemented in cooperation with the MOA and IPs. The "project" was the unit of analysis. Major crops were identified for each project area. The results of the assessment is that RAMP has restored the productive potential of 140,000ha previously waterlogged and saline land; protected 59,000ha land from flooding; and constructed diversion dams and intakes and cleaned canals to irrigate 280,000ha agriculture land. The impact of this endeavor are (i) improved irrigation has led to increased area, cropping intensity and higher total production. This has increased food security and net surplus for marketing; (2) Crop diversification rather than specialization is still the rule of the game, with wheat accounting for the major share in area cropped. However, through area shift involving the cropping of high-value commercial crops farmers have increased their aggregate output thereby increasing their participation in the market; and (3) on-farm employment was created for a large number of surplus labor as well as for construction workers. The total labour days was 1.9 million. Both men and women were employed

Using 2005 price, the total net benefit estimated for six years is US$1.2BN with a return on investment ratio of 60:1. A simple decomposition exercise indicates that US$464M, just under 40% of the total benefit, was obtained from area expansion, including area protected from floods. The remaining 60% of the benefit was due to increased productivity from currently irrigated and drained land. An estimated 330,000 households (about 2.6M people) are the direct beneficiaries.

The assessment indicates that investment on smallholder irrigation pays of well and if communities pool their resources together and manage and operate the rehabilitated systems properly there would be a sustained stream of benefit to accrue for at least 15 years. The irrigation projects have also important "drought proofing" consequences. Stability in crop output is as equally important as increasing it. Afghanistan has the

potential to increase agriculture productivity beyond the current level and be self-sufficient again. However, diversification to specialized high value labor-intensive cash crops is probably a better strategy for Afghanistan than food self-sufficiency. This will not only speedup the development process but also helps to eradicate the poppy culture

I. Introduction

Afghanistan is a landlocked country with an area of 65 million hectares, of which about 80% is either mountainous or desert. Climatic conditions are largely sub-tropical with cold and dry winter in the highland and arid and semi-arid in the lowlands. Most of the rains fall between October and March but with high variability. Afghanistan's economy is driven by agriculture and the majority of the rural people depend on it for their livelihood. Irrigated agriculture accounts for 43% of the total annual cropped area (3.5M hectare), generates nearly 85% of the annual agricultural output and provides livelihood (jobs, income and food) to nearly 85% of the population. Land holding is highly skewed. The majority of farmers are smallholders who cultivate about 2 hectares of land, depending on location.[1]

Topography and climatic conditions impose severe limitations on land use in Afghanistan. Nearly 80% of all crops produced in Afghanistan are produced under irrigation. There are three principal crop seasons in Afghanistan: (1) the spring season, roughly from March to June, during which the main crops are barley, potatoes and some vegetables; (2) the summer season, during which rice, maize, w/melon and seasonal vegetables are grown, beginning in July and ending with the harvest in October; and (3) the winter season, roughly from November to February or March, during which a variety of crops is grown, including wheat, potato, oil seeds, and pulses. In theory, two or three crops can be grown in most places, but actual cropping intensities – the number of crops per unit cropped area per year – are less than two. Over the past 20 years, the irrigation infrastructure has deteriorated for lack of maintenance and repair. Flooding and waterlogging followed by dry season drought and saline intrusion perversely affected agricultural production. Much of the irrigation system is in dire need of rehabilitation. A 1997 FAO/UNDP estimate is that out of the 3.5M hectare irrigated land, only 30% was 'adequately" irrigated; the remaining 70% was inadequately irrigated due to lack of maintenance or abandonment, destruction, and poor on-farm water management.[2] Some of the canals have also become dysfunctional due to missing mechanical parts and lack of skilled persons locally to maintain and operate them. This has had a detrimental effect on agriculture. As an example, area irrigated in Parwan declined from 25,000 hectare to 10,000 hectare due sedimentation in canals and poor maintenance.[3]

Irrigation has been recognized as a key for agriculture recovery and drought mitigation. Tremendous strides have been made by the government, farmers themselves and the donor community in rehabilitating irrigation infrastructure. It is probably the case that, despite enormous rehabilitation works done over the past 10 years most of the systems still remain dysfunctional and operate at sub-optimal level. One estimate is that currently 60-70% of the *karezes* are not in use and 85% of the shallow wells have also dried up, exacerbated by the recent drought that reduced the water level. In Western Afghanistan, water levels for

[1] Over 80% of the farms in the 1970s was 3ha (irrigated). RAMP PRA Studies in 2003 and 2004 give 3-4ha average irrigated land/household.
[2] Cited in FAO (2001) "Afghanistan Recovery and Reconstruction: Preliminary Needs Assessment of the Agriculture and water Sub-Sectors", Annexes.
[3] Bhattacharyya, K., Aziz, P. M.; Shobair, S. S.; and Mohsini, M. Y (2004)"Drought Impacts and Potential for their Mitigation in Southern and Western Afghanistan", IWMI, Working Paper # 91, Drought Series # 5.

wells have dropped by as much as 5 to 10 meters compared to the situation before the war. Moreover, boring of deep wells close to *karezes* and shallow wells has perversely affected the production of traditional irrigation systems by lowering the water table. Canals are silted, breached, and not functioning optimally. As a consequence the irrigation potential of the region has reduced from 17% to 88%, depending on the crops and area. Correspondingly, crop diversification has declined by 71% and productivity by over 50%. Animal population and productivity has also declined due to feed shortage.[4]

Agriculture productivity in Afghanistan is low, compared to regional averages.[5] Yields are low because of inadequate water supply and sub-optimal application of complementary inputs. From a near self-sufficiency in cereals in the early 1970s, Afghanistan has become a food deficit country, dependent upon external food aid.[6] FAO annual crop assessment surveys indicate a big shortfall between what is produced and required for food security. Even in good years many households are not able to grow enough food for home consumption.[7] A National Risk and Vulnerability Survey conducted in 2003 estimated that 3.5 million of the 17.5 million Afghans living in rural areas suffer from extreme poverty and another 10.5 million are vulnerable to it. An estimated 48% of the children under 5 are thought to be malnourished and suffer from stunted growth – twice more than its neighbouring countries and Sub-Saharan Africa and almost three times higher than the average for developing countries.[8]

The development of agriculture and economic growth at large is very much dependent on the development of irrigation systems. Irrigation, drainage, and flood control investments can drastically increase productivity. Irrigation will stabilize harvest fluctuations, allow the introduction of second crops and increase land productivity further making it possible for increased application of fertilizer, the use of better seeds, and improved crop husbandry practices to boost domestic food production. With improved on-farm water management and appropriate inputs a long-term goal of national average of 4-6mt/ha for irrigated wheat, 25-30mt/ha for tomatoes, 17-25mt/ha for potatoes and about 30mt/ha for onions is feasible. This has been realized in 2004 on RAMP-ICRADA demonstration fields under a range of agro-climatic conditions in the country.

---

[4] Ibid.

[5] Average cereal yield of 1,669kg/ha, for example, compares unfavorably with 2,048kg/ha achieved in Iran and 2,208kg/ha in Pakistan in 2002. Over the same year, with employment in agriculture similar to that of Iran, aggregate cereal production in Afghanistan was five times less than its neighbor; with agricultural land area more than 50% higher than that of Pakistan, Afghanistan produced seven times less in the same year. This gap in productivity is related to less intensive use of irrigation, among other things. FAO (2003) "FAOSTAT On-line Statistical Service". Available on-online at http://apps.fao.org. FAO, Rome

[6] In the late 1970s, Afghanistan was close to being self-sufficient in basic food grains and was a net exporter of agriculture products, with significant exports of raisins and nuts, See, World Bank (1978) "Afghanistan: The Journey to economic Development", Vols I & II.

[7] FAO annual crop assessment survey for 2005 indicated that Afghanistan will have to import at least 440,000Mt of cereals, comprising of wheat (337,000Mt), milled rice (101,000mt), and maize (20,000Mt). FAO/MAAHF "Agriculture Prospect Report", 2005.

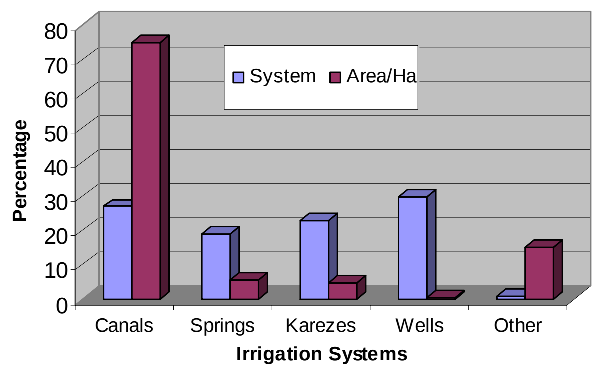
[8] Guimbert, S. (note dated) "Structure and Performance of the Afghan Economy". Technical Annex 1 to Chapter 1.

1.1 Afghanistan Irrigation Systems

Afghanistan has a long history of irrigation agriculture. Small community based irrigation systems like *karezes* and surface water systems have been established centuries ago as a means of ensuring food security as well as improving the standard of living of the rural people. A few large scale irrigation projects, like the Hilmand-Arghandab system in the South-West, the Khanabad system in Kunduz, the Ghaziabad farms near Jalalabad and Gavargan canal in Baghlan were constructed with external assistance before the war. Much of the land irrigated by these schemes has over the years been abandoned because of waterlogging and salinization. War and drought has also affected the efficiency of these schemes.

Basically, there are two types of irrigation systems: underground and surface. Figure 1 depicts the proportionate share of irrigation systems and the area irrigated by each system.[9] Underground systems – *karezes* (Qantas), and shallow wells *(arhads)* and springs account for 70% of the irrigation systems; canals account for 30%. However, only 15% of the irrigated land gets water from traditional underground systems. Springs irrigate about 190,000ha land; *karezes* irrigate 167,000ha, and shallow wells 12,000ha. Canals are by far the most important irrigation systems in the country. They irrigate 75% of the irrigated land. Most of the canal irrigated land is located in the North, West, and Southwest of the country.[10] Over 80% of the country's water resources originate from the Hindu Kush mountain as the snow melts during spring and summer and flows to major rivers. At different locations along a river, small diversion structures are constructed, some from local materials, to divert water from rivers to canals.

Figure 1. Share of Irrigation Systems and Area Irrigated in Afghanistan



The two most important irrigation methods, both from underground and surface water systems, are basin/border irrigation for cereals and furrow irrigation for vegetables and

[9] Data to compute the values were compiled from Afghanistan Recovery and Reconstruction; Preliminary Needs Assessment of the Agriculture and Water Sub-Sectors", December, 2001 and Qureshi, A. S. (2002) "Water Resources Management in Afghanistan: The Issues and Options", IWMI.
[10] Qureshi, A. S. Ibid.

fruit. However, water use efficiency is only about 25 to 30 percent, for both ground water and surface water irrigation schemes. Additionally, up to 25% of the water from *karezes* is wasted due to unregulated flow.[11] Farmers are aware of the intensity of irrigation (i.e. the number of times each crop should be irrigated) but are not knowledgeable of the timing and extent of irrigation requirements. Timing is crucial, since water supply has to be matched to crop requirements which vary through the growing season. Too much water can be just as inimical to agriculture as too little. Water being a common property resource, its true value has never been determined by the principles of the market. Inefficiency in water use limits intensification and growth in factor productivity.

Irrigation systems are commonly "owned" and managed by communities accessing them. Maintenance of the systems as well as distribution of water is managed on a communal basis under the supervision of the *mihrabs* while disputes over water resources are resolved by *vakils*. A farmer's access to water from both underground and canal systems is determined according to his area cropped, the kind of crops, the irrigation regime, and local practices. These arrangements are never formalized, leading to both inefficiency and inequity in the distribution of water. Moreover, in some parts of the country, traditional water management institutions have either become dysfunctional or obsolete leading to conflict amongst users.[12]

Low water use inefficiency, collapse of traditional institutions and deterioration of the systems and structures has several consequences for the development of agriculture. Improvement of on-farm management practices and repairs of existing canals could raise water use efficiency ratio to around 35% from its current level of 20 to 25%. This would improve agriculture production and also address inter-community conflicts over accessing irrigation water. Irrigation will allow farmers to grow a second crop, increase yields, intensify household labor and land use, and achieve a two to three-fold increase in production.[13] This may raise farm income and give farmers the incentive to disengage from illicit crop production which has become a menace to the country.[14] While declining prices benefit consumers, at the expense of producers, increased agriculture production can contribute to reducing rural poverty. This linkage between poverty alleviation and

---

[11] Qureshi, A. S. Op. cit.

[12] For an extensive discussion of water user associations in Western Afghanistan, see Qureshi, A. S. (2002) "Water Resource Management in Afghanistan: The Issues and Options" IWMI. Also available on line.

[13] The scope for increased agriculture production can be illustrated by some rough calculations. Assume that the average yield of, say, wheat could rise from 2Mt/ha to 4.5Mt/Ha, and still only 56% of the experimental station levels. This would increase total wheat output by approximately 10million tones (net increment) in Afghanistan. The net gains from wheat production would meet the annual shortfalls for domestic consumption of 0.5M tones and there will still be large surplus wheat for export. These assumptions are relatively modest: given appropriate technology and institutional support productivity much higher levels of productivity can be achieved.

[14] UNODC estimates the number of families involved in poppy cultivation in 2004 up by 35% to 356,000 compared to the previous year. In the same year, area cropped with poppy was 131,000. In 2005, the number of households engaged in poppy has gone down by 13% and the area cropped by 21%. However, the weather was good and disease was low and yields were above average. Consequently, gross returns from poppy for 2005 were only marginally lower than the previous year. See UNODC (2005) "Afghanistan Opium Survey 2005". Poppy is far more profitable than licit crops, partly because agriculture in Afghanistan remains traditional and farmers lack access to improved technologies and inputs to increase factor productivity.

increased agriculture production makes it even more important to investment on rehabilitation of irrigation systems in Afghanistan.

1.2 Scope and Objectives

Among numerous infrastructure repair requirements, RAMP has given the highest priority to rehabilitating irrigation projects. It has rehabilitated/constructed 33 irrigation systems and structures in the period 2004 to 2006 in eight provinces: Kunduz, Baghlan, Balkh, Parwan, Nangarhar, Hirat, Hilmand and Kandahar in cooperation with its implementing partners (see maps annexed). The primary justification for the rehabilitation of the projects was increased productivity and marketed output of agriculture crops, fruit and vegetables. RAMP had also a secondary objective - improving food security for Afghans. The projects may conveniently be grouped into four categories: dams, drains, flood control/protection walls and intake/canals. The rehabilitation work aimed at restoring structures to their original design level and in some cases to upgrade and expand the existing structures, and improve water use efficiency. The dams that have deteriorated were rehabilitated to capture and store water for agriculture and domestic use. The drainage projects aimed at rehabilitating waterlogged/salinized fields and reclaim waterlogged fields for agriculture activities. The flood control projects sought to avert the risk of land downstream being washed away by floods. The canal rehabilitation works included construction of new river intake systems, rehabilitation defunct “support” structures like culverts, bridges to ensure adequate and stabilized supply of irrigation water.

Out of the 33 irrigation projects implemented in the course of a three year period, ex-post impact assessment was conducted for 14; the remaining 19 projects were completed lately to impact agriculture production. The ex-ante assessment for the 19 projects is, therefore, forward looking projection assuming various scenarios. All but two of the irrigation systems rehabilitated are covered by this assessment. Two projects in Kandahar- Filco chute and a check dam - were dropped from the assessment, because the projects are too small and scattered and given the constraint in time it was not cost effective to field personnel to a province which is prone to high risk. The benefits attributable to the rehabilitation of the irrigation systems and structures are net value of the production foregone were the lands not protected and optimally irrigated.

The rest of the report is organized into three sections. Section 2 deals with the methodology, including data collection, the conceptual framework, methods to quantify benefits and the various assumptions that form the analysis. Section 3 deals with outputs and impacts. Realized and predicted impacts are discussed and measured. Benefits are compared against costs and investments justified. The concluding section looks forward and stipulates certain initiatives required to make the projects viable and sustainable.

II. Methodology

2.1 Data Collection

Estimating the impact of irrigation projects on agricultural production is a complex matter. Many factors affect impact. Baseline data was also not available for most projects. Proposals submitted by the IPs either over-estimate the acreage to be irrigated and protected or do not contain useful information to construct appropriate coefficients. Secondary source materials – if at all available – provided too general data that are extremely difficult to disaggregate by location and project. Several different methods were considered to collect the requisite information. Sample surveys could have provided a broader, more in depth information, but at a higher cost in time and professional expertise. The scope of the assessment also did not warrant such in depth study. Having evaluated possible options, the most economical method for data gathering, consistent with quality concerns, involved the Rapid Rural Appraisal (RRA) technique. Semi-structured questionnaires were developed to compile data following the usual convention of “with” and “without” rehabilitation. The form of the questions was to ask farmers how much area and yield (seers per jerib) without the rehabilitation and how much they are getting with rehabilitation. The irrigation systems were rehabilitated not long ago, offering the hope that estimated yields, area, crop mix, etc would not be biased by factors specific to a single season. After all, the harvest is important to farmers, so it seemed reasonable that they would remember their gains and losses with a fair degree of accuracy.

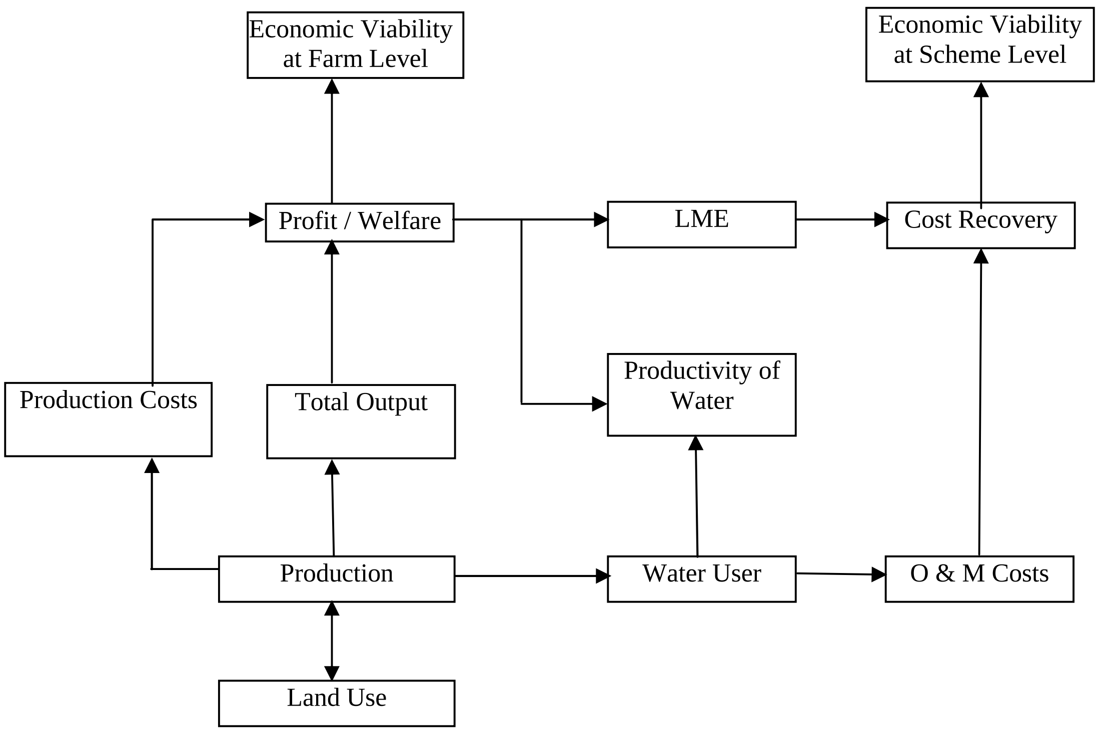
To complement the field survey, background information was compiled from provincial irrigation departments of the MOA and implementing partners. Project records (project preparation and implementation documents, project completion reports and periodic progress monitoring reports submitted by the IPS) were also reviewed. Informal interviews were carried out with specialists. These included MOA extension staff, department of irrigation specialists at the provincial level, personnel from specialised institutions like the Nangarhar Valley Development Authority and technical personnel from implementing partners. Parameters determined by the survey included irrigated area (command, net), cropped area irrigated, cropping patter, cropping intensity, production, net returns and the productivity of land. Annex 2 provides a list of the parameters surveyed. While these are relatively standard parameters of performance, available coefficients were not at the desired level of disaggregation to quantify benefits.

The survey was conducted by a team of persons per province, comprising of an engineer and agriculture specialist from RAMP and IPs, most notably from CADG and ICARDA. The teams were gathered for a one day workshop in Kabul to discuss and develop a common understanding of the concepts and refine the methodology and the questionnaires before fielded. The questionnaires were translated to Dari so as to ensure that the surveyors have a better grasp of the questions. The field survey was implemented over two weeks. To invite divergent perspective on certain parameters of contention and to validate/verify coefficients and assumptions, drafts were distributed for comments to specialists from RAMP. The assessment was completed having incorporated comments and suggestions from specialists. The result proved that an assessment of impact of interventions in small scale irrigation is feasible, and it can be done relatively quickly and efficiently using informal techniques.

2.2 Conceptual Framework

Rehabilitation of irrigation infrastructure brings significant changes at various levels, from farm to national levels. The impacts of these changes vary greatly, depending on the scale of impacts being evaluated and the nature and objectives of impact assessment. Impact at the aggregate level is measured by estimating changes in economic surplus. Irrigation is expected to bring a downward shift in the supply function resulting from increased production of commodities in the economy. Using cost-benefit method, impact is assessed by comparing benefits against total costs of irrigation, including economic, social and environmental costs.

Figure 1. A Conceptual Framework to Analyze the Impact of Irrigation Schemes



Source: Adapted from Ntsonto, N. E. (2004) "Economic Performance of Smallholder Irrigation Schemes. A Case Study in Zanyokwe, Eastern Cape, South Africa". M. Inst. Dissertation, University of Pretoria.

Project or farm level impact is more detailed and complex to measure than the aggregate level. Drawing analytical tools from the literature, a simplified model, tuned to the purpose of this impact assessment, is schematically presented in figure 1. Land use is a function of available technology, including irrigation. Farmers manage production at the farm level and market part of their products, which in turn generates income. The natural environment (e.g. climate, soils, pests, etc), among other factors, influences the production process. The institutional environment also impacts onto production, especially the customary rules pertaining to water rights. Perceived risks of an innovation and cost of production also influence production and the choice of crops - the level of intensification and diversification. The viability of the farm level operation is assured by net return to factors. A necessary condition for this is that farmers are able to irrigate crops at optimal level so that returns are high enough to cover production costs.

Individual households benefit from the scheme disproportionately but through equitable distribution of water, all farm households are able to access water to earn a stream of income overtime and are able to manage risks and shocks like drought. The local management entity (LME), like the mihrabs and vakils, not only oversees the distribution of irrigation water but also manages the operation and maintenance (O & M) of the schemes. It institutes a user cost recovery system. Revenues generated from water users are put back into the scheme to ensure its viability and sustainability.

A viable irrigation scheme generates a multitude of benefits, both direct and indirect. The direct benefits include, increase in agricultural production, increase in crop productivity, expansion in crop area, increase in cropping intensity and increase in crop diversification. Irrigation boosts total farm output and hence, with unchanged prices, raises farm incomes. Increased output levels may arise for at least three reasons. Firstly, irrigation improves yields, lowers the variance of yield and output and helps to reduce adverse consequences of drought. Secondly, irrigation allows for the possibility of double-cropping, and so an increase in annual output. Thirdly, irrigation allows a greater area of land to be used for crops.

Output may also be increased because irrigation enables the use of complimentary inputs, such as modern seed varieties and fertilizer as witnessed by the Green Revolution in South-East Asia.

The increase in output may result in lower prices for staples. Net purchasers of food, both rural and urban, will therefore gain from cheaper food. The effect of irrigation on prices and therefore on poverty may be particularly strong in remote areas with high transport costs where, pre-rehabilitation people had to purchase food from other regions. It may also be significant in areas with a comparative advantage in food production which can respond more strongly to the availability of irrigated land (e.g. if have surplus land and/or labor) and in areas with high surplus output levels which can be traded in wider markets.

Irrigation induces a switch from staples to higher value, market-oriented products, since not all the additional output due to irrigation is likely to be absorbed in self consumption, except by very small farmers. The switch of crops in irrigated areas may create or expand demand for crops of unirrigated areas, so leading to increased aggregate farm output.[15]

[15] Examples of this abound. In India, for example, the shift from rice to groundnuts and sugar in North Arcot, Tamilnadu and from wheat to mustard, rapeseed and groundnuts in parts of Gujarat is seen as a result of shifts into rice and wheat by lead areas in the adoption of modern varieties, which led to a reduction in supply of groundnuts etc and hence an increase in price. See, Lipton, M. and Longhurst, R. (1989), “New Seeds and Poor People”, London: Unwin Hyman.

Irrigation generates many indirect benefits, like increased employment in agriculture. There are two sources of additional demand for labor created by irrigation projects. First, increased farm output as a result of irrigation will stimulate demand for farm labor both within the main cropping season and across new cropping seasons, increasing both numbers of workers required and length of employment period. Second, irrigation projects require labor for rehabilitation and on-going maintenance of canals, wells, etc. Irrigation also induces increased employment outside agriculture from increased crop output in related industries such as input industry (backward linkages) and output processing industries (forward linkages).

Given the wide range of benefits to accrue from irrigation, it would be extremely costly to try and measure all the benefits. The selection of variables for assessment has to be driven by the focus of the study, which in this case is to determine the incremental benefits in terms of increased agricultural output. In other words, the assessment is concerned with measuring the direct benefits stipulated above.[16] Data are treated in spreadsheets and annexed to this report (Annex 3A to 3H). Multiplier effects and broader development impacts of projects (like marketing and other services, rural industries based on agro-processing, etc) are not captured by this study.

2.3 Quantification of Impacts

The technique adopted to quantify impacts is "with and without" comparisons as opposed to the "before and after" convention, because the latter approach fails to account for changes in production that would occur without the project and often leads to erroneous estimates of impacts.[17] The "with and without" approach too suffers from similar limitations, but it is commonly used in cases where data before intervention are not readily available as is the case with the RAMP projects. Impact is measured as the difference between with and without rehabilitation i.e. the actual change in impacts or the net incremental gain produced by the rehabilitation of irrigation systems. The benefits are then valued using constant prices so as to directly compare benefits in real terms. Benefits from drainage, flood control as well as canals trickle in small amount as farmers progressively increase the area cultivated. This leads to a low cash flow in the first few years, which eventually becomes larger when the projects reach "full development" year. Benefits are computed on a "per hectare" basis as opposed to a "typical farm" basis.

Financial analysis was also conducted for each project. The analysis follows the "time adjusted cash flow approach". This means that the initial investment is considered to have taken place during the first year of the project. In order to compare costs against predicted benefits that are likely to be generated through the rehabilitation works, the internal rate of return (IRR) and the net present value (NPV) were computed for each project.

[16] Other direct benefits include increased access to water for domestic use and for livestock, reduction in the opportunity costs of water uses, and fisheries. These are not measured by this assessment.
[17] For further discussion on the merits and demerits of with/without and before/after methods, see Gittinger, J. P. (1982) "Economic Analysis of Agricultural Projects", Baltimore: Johns Hopkins, University Press.

2.4 Assumptions and Coefficients

A number of assumptions and coefficients are developed to impute benefits. These are elaborated in this section.

First, the command area had to be defined. The IPs in their proposals assume that the entire command area is irrigated area. This is not necessarily true, however. For example, when the DAI information for Gurgurak and Ab Qul canals, Baghlan province, was compared with data generated by GIS, it became apparent that the DAI included rangeland and marshland in the total command area. A correction factor had to be introduced in order to ensure that the acreage reported by the IPs does not overestimate the actual cultivated areas. Thus a 10 to 15% was taken off of the reported command area to derive the "culturable command area", defined as the area that can be irrigated by an irrigation scheme and is fit for cultivation under current farmer technology. This deduction in acreage also provided a cushion against overestimation of irrigated land with-rehabilitation.

Another issue concerned the difference between total and net cropped area, analogous to net sown area. Having adjusted for data inconsistency in the definition of command area, net cropped area and additional land brought into cultivation with rehabilitation were determined for each project. The former is the sum of area under winter, spring and perennial crops (excluding summer crops). Hence, the percentage of net cropped area is somewhat lower than the percentage of total cropped area.

There is also the question of whether "irrigated area" refers to crop land that receives **any** irrigation, however inadequate, or only to crop land that receives adequate irrigation for an optimal growth of plants. Ideally, one would like to have a breakdown of acreage according to irrigation coefficients, defined as the ratio of the quantity of irrigation water to total water requirement, rather than a simple binary classification into irrigated and un-irrigated land – which is a common practice in Afghanistan. Even then a conceptual problem would remain, since water requirements vary according to crop, and the latter is one choice variable by which the farmer responds to water availability. In practice, only a crude three-way classification of acreage was constructed – optimally, sub-optimally, and poorly irrigated. The without rehabilitation area was divided into these three classes of land use, and the proportionate share of each class in the total acreage was determined using information from job orders.

Output estimates are derived having adjusted the acreage under each crop. The irrigation survey gave exceptionally high crop yields for with-rehabilitation. This was substantially scaled down to compute incremental gain. A "low-median" yield was computed and this same yield was retained for the whole period even after the land was brought into "full development" – in year three.

Rehabilitation of the irrigation systems will enable farmers to increase their area irrigated. It is premised that the additional land will be brought into cultivation incrementally. In high-population density provinces where the average cropped land per household is relatively small – like Parwan and Nangarhar – additional lands could be brought into cultivation in a short span of time as long as irrigation water is adequate enough and farmers have labor and inputs. Conversely, in Hilmand and Kunduz, acreages are above average and additional lands may be brought at a slower pace. This assumption does not always hold true; even in Parwan and Nangarhar, the average irrigated area/household in some locations is comparable to the acreage in Hilmand and Kunduz. The analogy may also not hold especially for those areas whose total acreage covered by the project is small and the with-rehabilitation benefit is due to increased crop productivity rather than area expansion. Thus in order to standardize benefits, it is assumed that all additional land, following rehabilitation of the irrigation projects, will come into full use by year three or less.

The cropping pattern was established by the irrigation survey, which captures the important crops cultivated in the particular location. The sum of the winter, spring and perennial crops (excluding the summer crops) provides a good measure of the acreage cropped in a season. In most cases this ranges between 85 to 95% for optimally irrigated land and somewhat lower, 40 to 60% for sub-optimally irrigated land. The area poorly irrigated has a much lower cropping intensity. It is assumed that all the land that was sub-optimally and poorly irrigated without rehabilitation will be adequately irrigated with-rehabilitation. This is an important assumption, because it implies that with rehabilitation farmers will have adequate water to irrigate all the land optimally. But again because yields are deliberately kept below the median and the total cropped area is much less than the command area, any probable overestimation of benefits from this assumption will be offset by the two factors alone.

Benefits come from “horizontal intensification” involving area expansion, increased productivity and increased cropping intensity as well as “vertical intensification” involving area shift from low value cereals to high value vegetables and fruits. Area shift links producers with processors and exporters. The extent of this shift reflects the stage of development in the country, increasing in magnitude as the country industrializes. Based on current knowledge of economic returns from different crops, and the production strategies of Afghan farmers - which often emphasizes food security from own production - a 3 to 5% shift area shift is not unrealistic target with rehabilitation of irrigation systems. Area shift coefficients are introduced in year 4 after “full land development” is achieved in year three – to account for a dynamic nature of agriculture. Where water is believed to be a binding constraint even after rehabilitation, like in Hilmand, Hirat and Balkh, a 3% area shift from low value crops (proxied by maize and barley) to high value crops (proxied by potatoes, tomatoes, onions and melons) will occur every three years. For Parwan, Nangarhar and Kunduz, a 5% area shift is predicted to occur every three years, starting in year four. The rationale for this is that: a) water is not a major constraint for area expansion in the latter three provinces, except probably in some locations in Parwan. Second, agriculture in these provinces is more dynamic in which farmers are integrated into bigger markets in the country and abroad. Driven by high population pressure - expressed by area cropped/household, except perhaps in Kunduz - agriculture in Parwan and Nangarhar provinces is relatively more commercialized and easing up water constraints would provide farmers the incentive to grow more high value crops by taking off land from inferior cereals.

To derive the cropping intensity, the actual cropped area is summed up for all the seasons and divided by the total cropped area rather than the command area – which is the usual practice – because, as stated above, the command area is not necessarily cultivable area as such. The cropping intensity calculates the percentage change for the third year, because all the additional land will by then be brought into cultivation with rehabilitation. The usual method of calculating cropping intensity is to derive the proportion of total area under various crops to total cropped area. The higher the ratio, the more intensively the land is said to be cultivated. However, this method gives equal weights to all crops – irrespective of how many seasons they take to produce. There are annual crops, like sugarcane, and perennials like fruit and nut trees, and it will be inappropriate to compare these with, say, peanut which needs a maximum of 5 months. In order to overcome this problem, adjusted cropping intensity (ACI), defined as the proportion of total area under all crops (area under long-term crops times 2 + area under other crops) to total cropped area, is calculated for each irrigation.

Crop intensification, defined as multiple cropping in a season on the same land, has also been considered but it became apparent that in the absence of short maturing crop varieties, farmers would be reluctant to intensify crop production. For agronomic reasons, second cropping of high-value crops appears not feasible, except perhaps in the warmer climates of Hilmand and Balkh. But here too it would not be an attractive proposition as vegetables require more water in the hot summer season. Moreover, Afghan farmers prefer to leave the land planted with wheat fallow until the next season rather than crop something else on it.

Crop diversification and concentration is assessed using the Herfindahl Index.[18] The purpose is to gauge any emerging pattern in crop shift, from low value crops to high value crops.

Crop prices have peaks and slack, depending on the season. They tend to rise in the winter season, especially for vegetables. The median price would in this case be an appropriate value, but the basic data was not readily available for all crops. In consultation with RAMP specialists an attempt was made to construct "low-median" slack season prices. Here too, the use of constant and low prices mitigates against overestimation of benefits.

[18] The Herfindahl Index of crop acreage calculates the degree of concentration among crops. The index increases in concentration and declines when more crops are grown and each has a relatively smaller share of the total. Let *Si* be the share of crop *i* in the sum of the principal crops covered in this study, in terms of acreage. The Herfindahl Index is defined as $H = \sum S_i^2$ Where S_i is the share of the i^{th} unit and each unit represents one crop: wheat, tomatoes, grapes, etc. Like the Gini coefficient, the Herfindahl index increases in concentration, with perfect specialization taking an index value of one.

In each case, benefits are claimed for six years. In the first three years, the additional land will be brought into cultivation incrementally. In the next three years, area shift will begin to take place.
For those projects completed before the cropping season of 2005, benefits start to flow from year one. Conversely, for projects completed after the cropping season of 2005 and for those completed in 2006 benefits start flowing from year two. That is to say, the first year “benefit” is simply a “base year” and the actual stream of benefit begins to flow from year two onward.

Impact is measured for the life of each project independently. The technical life of the projects is determined by RAMP irrigation engineer, having considered the annual maintenance and operation requirements. Costs thus embody investment or capital costs plus maintenance costs for the appropriate years.

Financial analysis was conducted on each project to judge its impact. The analysis follows the "time adjusted cash flow approach". This assumes that every transaction falls at the end of the accounting period, which is the end of year in this case. This means that the initial investment is considered to have taken place during the first year of the project. A constant price approach was also adopted, thus expressing the costs and benefits in real terms. In order to assess the financial viability of the projects, the internal rate of return and the net present values were computed for each project. Benefit-cost ratios were also computed for each project. The intakes/canals may last over 30 years, but their effectiveness will fall through time due to silting and breakdown. Moreover, at the discount rate of 12% and the opportunity cost of capital in Afghanistan, any return to an investment beyond about 15 years will make little difference to the present worth of benefits. Efficiency tests were therefore conducted for 15 years by running financial rather than economic rate of return.

III. Results

Impact was evaluated in terms of economic benefits. The results suggest that substantial agricultural changes are taking place in the communities serviced by the projects. However, some projects have more impact than others and generally projects in the major agriculture producing provinces – Kunduz and Baghlan- have more positive impacts than those in the other provinces. These changes derive from improvements in land use and production. The projects have extensively used local labour for rehabilitation works. The total employment of the rehabilitation works was 1.9million labour days. Both men and women were employed. Some of the irrigation projects, like Barq canal in Jabulsarage district, Parwan, are generating electricity for the community. The following outputs and impacts are measured:

3.1 Land Reclamation

Construction of drainage systems, coupled with some land smoothing works and irrigation systems improvement, and leaching and drain maintenance works by RAMP has restored the productive potential of about 140,000ha farmland. In areas where the drains were completed a year ago, farmers were able to cultivate land recovered and increase their production.

Drainages also raise the productivity of farm lands and encourage farmers to adopt best practices. There is a strong relationship between saline-free farms and fertilizer use, for example. Farm lands affected by drainage problems do not produce enough to cover costs of modern inputs. Earlier studies in Hilmand suggested that drains can raise average crop yields by at least 20% due to the use of best practices.[19] Total production in the project locations can be expected to increase at this rate over the next 6 years.

Through the rehabilitation works, 59,000ha of land was protected from flooding. Most of the structures are located in Nangarhar and Kunduz provinces. One of the most important projects - the Khanabad dam in Kunduze province – was constructed before the war, but through time the protection walls lost ground and flooding was threatening 50,000ha high potential cereal land. Nationally, this was a strategic project because the area produces substantial quantity of cereals annually. An estimated 17-20,000 farm households depend on the land for their livelihood. With a modest investment of US$226,504, the land was protected from flooding. In addition, 24.5km rural road that runs through the farmland was saved from being washed away.

The rehabilitation of canals and the construction of diversion dams have also enabled farmers to optimally irrigate 280,000ha land and increase their output. In general, about 9% of the increase in area irrigated is additional land which was made possible through the rehabilitation of irrigation systems. In absolute terms, the net gain was about 45,000ha.

3.2 Agricultural Production

Irrigation permits the growing of crops that would not be grown under dryland conditions, like vegetables. With rehabilitation, the area planted with fruit and vegetables has increased substantially. As an example, vegetable area has increased 3 fold in Nangarhar (Shaghee canal) and Kunduz (Chardara canal) and doubled in Parwan (Charikar canal). The production of high value crops, both for local and export markets, means that farmers are participating in the mainstream economy. The Balkh irrigations are not expected to produce high value crops on a large scale and their yields are likely to remain low just above the current level, primarily because water will continue to be inadequate to optimally irrigate high-value crops of fruit and vegetables. The schemes in Balkh are therefore generating modest net output.

Average yields for sub-optimally and poorly irrigated crops are predicted to rise to the level attained under optimal irrigation condition. Crops which still have substantially low yield per unit land are likely to see even larger average increases in yields when the new area brought under the crops is optimally irrigated.

---

[19] This level of productivity was obtained from drained lands in the Hilmand Valley in the 1970s. See, USAID (1976) “Central Helmand Drainage, Phase II”.

3.3 Cropping Pattern

Low value crops such as wheat, grain maize and beans dominate the cropping pattern. Wheat remains the predominant crop, covering up to 40% of the total cropped area in a season. The share is relatively high in some locations in Nangarhar and Hilmand, reaching up to 60 and 46%, respectively. Conversely, fruit and vegetables as a group account for a higher share of area cropped in Nangarhar and Parwan compared to other provinces. The theory of growth linkage (re: Von Thunen's theory) suggests that the diversity of land use would be maximized in central market rings and would give way to inferior cereals with increasing distance from towns and markets. The expansion of markets (and a possible reduction of transport cost) would lead to a linear expansion of the zone of diversification and intensification in land use and an exponential expansion of its production. The cropping patterns observed for the irrigation systems are responses to availability of water but their cultivation is crucially dependent upon market opportunities. Being close to major markets for perishables and easily accessed by transport, Nangarhar and Parwan have proportionally more land under fruit and vegetables than other provinces.

3.4 Crop Diversification and Concentration

Diversification of crop production is a common feature. Farmers generally grow cereals as well as vegetables. Fruit production is location specific. Neither scheme displays concentration toward crops with comparative advantage. Measured by the Herfindahl Index, the share of cereals far more outweighs the share from vegetables and fruit. This is not just a matter of resistance to technology; it is due to a combination of factors, not least irrigation water that places limitation on the type of crops planted as well as the semi-subsistence nature of Afghan farming. Moreover, horticultural crops demand a lot of labour and they are not easy to market. The disincentive created by the poppy phenomenon, which discourages farmers from planting labour intensive high value crops, is another reason for the lack of specialisation. It is probable that if farmers were to be vertically integrated with processors and exporters of high value products, their cropping patterns would change in favour of commercial crops.

3.5 Cropping intensity

Adjusted cropping intensity was calculated for each project for year 3 from the annual irrigated area (Table 1). It is noticeable that intensities without rehabilitation were below one a number of irrigation systems. With rehabilitation, cropping intensities have changed significantly, partly because of the additional gain in area cropped. Among the irrigation systems, the highest adjusted cropping intensity was obtained for Barq and Afghan canals in Parwan. Almost all the irrigation systems in Baghlan and Balkh have also achieved high cropping intensities. The lowest cropping intensity was obtained for Matak canal in Parwan. The percentage difference between the with and without irrigation is quite striking in almost all cases, suggesting the significance of irrigation for agricultural change.

Table 1. Irrigation Intensities and Benefits

Project	Irrigation Intensities		% Change[1]	Net Benefit Area Shift	
	Without Rehabilitation	With Rehabilitation		Ha	US$
Kunduz					
Khanabad Dam Protection	1.22	1.22	0.00	138.9	167,668.8
Chardara Canal	0.96	1.49	0.95	105	126,747.5
Baghlan					
Darqad Canal	0.89	1.41	1.23	105.2	127,001.0
Ab Qul Canal	0.87	1.51	0.73	146.1	176,456.7
Gurgurak Canal	0.96	1.51	0.58	23.29	28,113.8
Baladoori Canal	1.10	1.61	1.20	29.6	35,730.7
Nangarhar					
Kanday Protection	1.36	1.36	0.31	15.62	18,855.2
Batikott/Kama Drains	1.15	1.53	0.33	112.4	135,680.2
Shegee Intake Canal	0.98	1.39	1.03	6.56	7,918.7
Kotti/Kachar Canal Intake	0.84	1.24	1.11	13.59	16,404.7
Nangrahar Canal Km 64 to Km 70, Subcanal 30, 31$ Flood Diversion I	1.28	1.28	1.69	9.89	11,938.4
Flood Diversion Dam II	1.36	1.36	0.67	4.32	5,214.8
Parwan					
Barq Canal Intake Diversion Dam	1.24	1.85	1.00	15.08	18,203.4
Belawdan Canal Diversion Dam	0.95	1.40	0.77	5.45	6,578.8
Afghan Canal Diversion Dam	1.18	1.72	0.75	15.4	18,589.6
Toghbirdi Canal Diversion Dam	0.76	1.13	0.92	13.68	16,513.4
Ibrahim Khil Canal Diversion Dam	0.88	1.32	0.68	20.7	24,987.4
Mahigir Canal Diversion Dam	0.73	1.27	1.26	3.34	4,031.8
Matak Canal Diversion Dam	0.68	0.97	0.86	168.5	203,447.8
Akhtarchi Canal Diversion Dam	0.89	1.34	0.87	50.45	60,899.2
Charikar Canal	0.91	1.34	0.64	55.23	66,669.2
Hirat					
Guzara canal	0.85	1.41	0.92	4.16	5,021.6
Injil Canal	0.85	1.30	0.76	4.79	5,782.1
7 Qalb Canal	1.28	1.31	0.10	0.99	1,195.0
Hilmand					
Shamalam, Darweshan and Upper Boghra & Nade-Ali Drains	1.09	1.53	0.49	203	245,045.2
Marja Drains Phase II	1.05	1.50	0.50	69.2	83,532.6
Boghra Canal Cleaning, 35 to km 70	0.83	1.55	0.88	63.4	76,531.3
Balkh					
Chemtal Canal	1.38	1.67	0.58	55.91	67,490.0
Mushtaq Canal	1.38	1.70	0.60	72.53	87,552.3
Abdullah Canal	1.20	1.40	0.52	181.4	218,971.4
Dawlat Canal	1.38	1.71	0.48	255.7	308,684.5
Total				**1,969.5**	**2,377,457.1**

Note: Annual intensities are calculated from total irrigated area for each irrigation status (without and with). Intensities are high for with rehabilitation partly because of the additional land brought into cultivation. The percentage change however captures the net incremental higher than the productivity of subsistence crops.

3.6 Area Shift

The rehabilitation of irrigation systems has important implications for allocation of area to various crops, both in relative and absolute terms. Investment decisions by farmers, particularly decisions regarding area shift from low value to high value crops, would be expected to depend on their perception of the risks involved relative to the possible benefits. This involves expectations about uncertainties regarding the average yield increase that the switch would bring about,) the extent of fluctuations in crop yield and in returns to labor that would result from the switch compared to continuing with the traditional cropping pattern and net returns from different crops.

Area shift is premised on the basis that farmers can increase cereal productivity with rehabilitation and grow more high-value crops without compromising on their food security first strategy. Moreover, the productivity of market-oriented crops is generally high. For subsistence crops like wheat, rice and maize the effect will still be positive gain, both in area as well as intensification of crop production, achieved with rehabilitation in relation to without rehabilitation. Average gain/ha US$ =1,207.1 but small implying that farmers can reduce the area cropped with these crops and still increase their gross return per unit land. It is calculated that through area shift, there will be a net gain of about 2,000ha and a net benefit of US$2.4M over the three year period, year four to six. The predict area shift will in probably occur earlier than year four as assumed in the model, because the acreage shift is small, both in absolute and relative terms.

3.7 Food Security

Using output for year three, the year in which all additional land is predicted to be optimally used, per capita food availability was calculated from the aggregate cereal production (wheat, rice, maize and barley) for each of the locations where the irrigation systems are located (Table 2). Assuming a per capita cereal requirement of 160kg/person/annum, 8 irrigation schemes, 6 of which are located in Parwan, produce surplus food (cereals) somewhat less than the per capita requirement. This is probably because agriculture in Parwan is driven by the market than any where else in the country in which most farmers allocate more land to grow commercial than subsistence crops. The irrigations with high surplus production are located in Kunduz and Baghlan, and two of the schemes in Balkh also produce large surplus. Needless to say, all the 33 irrigation systems have increased agriculture production with rehabilitation and hence per capita food availability. With an average per capita cereal availability of 278kg, food security is assured for the population accessing the irrigation systems.

Looking ahead, a number of secondary benefits are expected to accrue as a result of the rehabilitation of irrigation systems. Quantifying these benefits at this stage is premature, because for impact to be realized a good deal of time will have to lapse after projects are implemented. The following changes are predicted to take place over the coming years:

3.8 Crop Intensification

Lack of assured irrigation forces farmers to fit agricultural activities with the changing seasons. Optimum productivity in farm operations under this scenario is difficult to achieve. With priorities focused on meeting basic subsistence need, innovative approaches and practices are resisted. Thus, most Afghan farmers practice standalone cropping rather than multiple cropping, despite its immense economic benefits.[20]

Low crop productivity translates into low feed availability (due to limited cropping options) and hence low animal output. In a small farm environment, crop and animal production complement each other through the utilization of plant residues as feed for animals as well as the use of manures as source of organic matter for crop production. Improved irrigation is crucial in strengthening this interaction. With improved irrigation, crop intensification will be feasible, further improving crop-livestock productivity.

Like crop intensification, double cropping on irrigated land will prove to be an important source of growth in agriculture. The practice of consecutively growing two crops of either like or unlike commodities on the same land within the same year will be an attractive proposition with irrigation. Farmers will be able to use the land that remains without a crop in late spring, after barley, and in the autumn, after the main crops of rice and maize. They can plant early maturing crops, like potatoes and other vegetables in the summer and autumn and optimize land use. The Southern and Eastern regions of the country with long growing seasons have favorable climatic conditions for double cropping.

3.9 Backward and Forward Linkages

Increased demand for inputs from dealers, necessitated by the expansion of agriculture activities, induces forward linkages. Fertilizer dealers interviewed in Parwan province reported increased input turn over, implying the benefits of irrigation on the use of improved technology. The demand for some vegetable canning and grain processing private companies is an example of forward linkage offered by the irrigation schemes. By increasing their marketed output, farmers also create businesses in the private sector. Transport, which is hired for marketing of surpluses, is another example of forward linkage. The rehabilitation of over 500km farm to market roads by RAMP will in this respect be a catalyst for expanded marketing activities. Synergies between sectors will deepen and the cumulative impact will promote economic development in the country. It has not been possible to value any of the benefits stipulated above, mainly because the linkages are at the early stage of development. No doubt, however, through time they will deepen and become significant.

[20] Multiple cropping reduces the risk of total crop failure, optimizes production from small plots, maintains soil fertility if complemented with legumes, and ensures cropping throughout the year.

3.10 Estimated Value

The flow of benefits is assessed incrementally. The layout and procedures for calculation of benefits is depicted in Table 2. All the benefits are derived from 2005 prices. The total net benefit from rehabilitation of 33 irrigation projects is US$1.2BN over six years, benefiting an estimated 2.6 million people (Table 2). This gives a return on investment ratio of 60:1, which can be accredited to RAMP and its implementing partners. A simple decomposition exercise indicates that US$464M, just under 40% of the total benefit, was obtained from area expansion, including area protected from floods. The remaining 60% of the total benefit was due to increased productivity from current irrigated and drained land. Some schemes with a high proportion of poorly irrigated land are likely to generate higher economic rate of returns and higher impact on output per marginal dollar, than relatively better endowed or irrigated areas. Overall, benefits trickle in small amounts annually as farmers progressively increase the area cultivated. This leads to a low cash flow in the first few years, which eventually becomes significant when the projects reach "full development" in year 3.

Financial cash flows and discounted benefits are also calculated for each project (Table 2). The NPV was found to be positive in all cases, indicating that the projects are viable. The IRR is also much higher than the discount rate for all projects, indicating their viability.

IV. Conclusion

Afghanistan's agriculture has yet to recover from the effects of war and drought. Large quantities of cereals are imported annually to supplement food aid. In order to improve food security and increase incomes, agriculture will have to grow faster than the current level. Both horizontal and vertical intensification will be essential to increase productivities and incomes in Afghanistan. Opportunities to increase agriculture production by expanding the cultivable area are not very encouraging, given the limited cultivable area. Moreover, the land to man ratio is declining rapidly in the country due to high rural population growth. Area shift holds the key for the future development of Afghanistan. Smallholder irrigation plays a crucial role in supporting this strategy. With the development of agribusiness and agro-processing plants, farmers will be able to grow more commercial crops and increase their income. Thus, irrigation development will also be a vehicle for the long term agricultural and macro-economic development of Afghanistan. As the experience of South-East Asia indicates, rehabilitation of existing irrigation systems can have higher economic rate of return than either new irrigation development or other types of investment in agriculture.[21]

However, management of operation and maintenance of irrigation schemes affects the cropping pattern and the general viability of irrigation systems. If communities were to pool their resources together and resolve problems related to operation and maintenance,

[21] An evaluation of 192 World Bank projects in developing countries indicated that the economic rate of return from investment in irrigation is substantially higher than hitherto thought and more than any investment in agriculture. See, Carruthers, I. (1996) "Economics of Irrigation,' in L.S. Pereira et. al. (eds), Sustainability of Irrigated Agriculture, pp. 35-46.

including free-rider problems, small-scale irrigation systems will be more profitable to drive up agriculture production. And if farmers were to pay for some of the basic operation and maintenance costs, cleaning canals, etc the systems can be self-sustaining. It is recommended that some cost recovery measures should be instituted to make farmers more responsible for water use. It is indeed ironic that in a country where agriculture is almost entirely dependent on irrigation water, little has been done to rationalize water use. Water use inefficiency translates into irrigation inequality and low agriculture output. Interactions with farmers during the survey indicated that farmers, especially those at the tail-end, do not get appropriate quantities of water at appropriate times. Much of their land is in effect irrigated sub-optimally or poorly. Water management and water pricing will ensure not only equitable access to water but an efficient use of water. RAMP has made some progress in this regard through the formation of a water user association in Hirat. Some of the preliminary work was also completed to establish a similar association in Hilmand. The initiative strived to formalize and legitimize the high de facto farmer participation in irrigation management that existed from the start. It is important to build on this effort for a sustained development. Studies of successful smallholder irrigation projects in Sub-Saharan Africa indicate that a combination of supply augmentation (vis rehabilitation and construction of irrigation systems) and demand management will be required to optimize water use and increase agriculture production.[22] With a proper management and operation of irrigation systems, water distribution will be more equitable and agriculture production in Afghanistan can increase quite substantially.

The assessment has also shown that in future irrigation rehabilitation/construction should take on an integrated development approach, covering other key sector activities, like roads and agriculture technology dissemination. This will create synergies between sector activities such that farmers will be able to get better market information, grow more market-driven crops and increase their margin.

[22] Shah, T.; von Koppen, B.; Merrey, D.; de Lange, M,; and Samad, M. (2002) “Institutional Alternatives in African Smallholder Irrigation: Lessons from International Experience with Irrigation Management Transfer”, IWMI, Research Report # 60.

Annex 1: Maps

Annex 2. Parameters Measured by the Survey

The following checklists were developed for surveyors. Each team comprised of an agriculture specialist and an engineer.

1. Determine the total area waterlogged/salinized and the reduction to productivity by project.
2. What proportion of the lands salinized can be considered as "very severe' "severe", and "moderate"? (This three way classification of salinization corresponds to the description given for Chardar canal in Kunduz). Determine the level of salinzation for each canal project.
3. Estimate the area drained that will be brought into cultivation incrementally (Yr1…..Yr10. The period may stretch beyond year 10, depending on the project).
4. Suggest coefficients to measure incremental benefits from agriculture land drained (land which was cultivated before the drains but yielding relatively low output). This is likely to be area-specific. Please suggest coefficients for each of the drainage projects.
5. By how much have drains alleviated the problem of waterlogging and salinization and restored the productivity potential of the lands (holding other land improvement practices done by farmers constant)? What is your best guess for the decline in productivity of crops before the drains?
6. Suggest if the coefficients developed for drains by USAID before the war for Hilmand could still be applicable. The USAID estimate for average yield improvement post-drains in Hilmand was 20%. This was considered as the minimum acceptable target to justify on an economic basis drainage works. What is your best guess?
7. Suggest by how much average productivity of crops will increase annually before reaching the maximum yield as a result of the drainages.
8. Not all the land can be considered adequately irrigated. If a three way classification is used: poorly irrigated; sub-optimally irrigated; and optimally irrigated, we would be able to more accurately measure the impact of irrigation water on productivity? Show the proportion of land under each category without and with rehabilitation of canals.
9. The following weights are established from the literature for productivity changes for crops irrigated at various levels: for cereals 32% increase from sub-optimal to optimal; for cotton and oil crops 25% increment; for vegetables 35%. Would you agree with these weights or do you have a norm for Afghanistan? A more detailed weights developed in consultation of Dr Samin and Abdul Qudus are also included. Please review these weights and comment.
10. We know the total area or command area for each project. Can you estimate a) the total or command area irrigated annually; b) the net area irrigated annually; and c) the cropped area annually. Impact values are very much susceptible to these coefficients.
11. Some of the irrigation projects completed a year or two ago my have already induced changes in cropping intensities and crop diversification. Can you say which of the

irrigation projects have achieved this, and what would be your best estimate of the change? Please give changes in percentage.

12. Suggest coefficients to measure incremental benefits from increased and assured supply of water for optimum plant growth and maximum possible yield due to the rehabilitation of existing irrigation structures. In our draft impact assessment we used 40% incremental gain for canals. Is this acceptable to you? What is the norm for Afghanistan?
13. Suggest coefficients to measure incremental benefits from increased and assured supply of water for optimum plant growth and maximum possible yield due to the rehabilitation of dams (land which was cultivated before the construction of dams but yielding relatively low output).
14. Suggest coefficients to measure benefits from agriculture land protected from floods (land which was cultivated before but yielding relatively low output because of floods). This is also likely to be area-specific. Suggest coefficients for each project.
15. Suggest coefficients to measure benefits from newly irrigated fields. Can we ascribe 100% of the output from newly irrigated lands to the rehabilitation of irrigation structures?
16. What was the average area, yield and crop mix "without" and "with" rehabilitation of the irrigation systems (kg/ha). Please complete the table below.

	Average yield	Area irrigated		Double cropping		
Crops	without	with	without	with	without	with
Wheat						
Rice						
Maize						
Barley						
Cotton						
Sesame						
Flax						
Potato						
Tomato						
Okra						
Onion						
Eggplant						
Cauliflower						
Cabbage						
Carrot						
Melon						
Other crops (list):						

Annex 3A to 3H Worksheets

Annex 3A. Baghlan Province

Annex 3B. Balkh Province

Annex 3C. Helmand Province

Annex 3D. Hirat Province

Annex 3E. Kandahar Province

Annex 3F. Kunduz Province

Annex 3G. Nangarhar Province

Annex 3H. Parwan Province